focus:**Innovation**

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Keeping trucks on a cleaner path: When Volvo sought out a novel fuel platform for its new heavy duty product lines, Chemrec came up with a new, cleaner, solution – methanol and dimethyl ether (DME) – which can be derived from biogas waste streams

Biogas streams produce clean fuels

BIOGAS STREAMS can produce innovative and superior diesel replacements, which could be used in vehicles to improve efficiency and help meet ever more stringent environmental stipulations, reports Nicholas Zeman.

When Sweden's **Chemrec** heard that **Volvo** was searching out a novel fuel platform for new heavy duty product lines, the synthesis gas refining company wanted to act. OEMs like Volvo build the market for renewable fuels, and their support is essential to the continued success of companies like Chemrec around the world.

As a customer, Volvo was showing what they wanted from fuel suppliers; what followed was a US$25 million project along with other big players like **Total SA** - demonstrating the logistical feasibility and technical superiority of a fuel Volvo said was its "favourite."

The auto maker had initially created a matrix for the same truck with 7 different fuel systems and 7 different performance variables - methanol and dimethyl ether (DME) emerged as the winners:

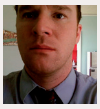
"Volvo said, 'we can build a truck for any fuel, but we don't like all fuels'. From its efforts it felt DME and methanol were the best fuels", says Invar Landalv, Chemrec.

Recently, Volvo announced that it would base a new line of heavy duty trucks on DME to start production in 2015 in a partnership with fellow heavy duty **OEM Mack Trucks**.

The innovations in diesel technology - emissions reductions combined with superior power and fuel range - increased the popularity of the sector over recent years. Diesel also remains the work horse of the transportation industry. But biogas has an opportunity here and through DME is being offered an inroad into the market.

When biogas is produced from anaerobic digestion and turned into dimethyl ether, it can be used to propel diesel and LNG vehicles, but achieves 97 percent reductions in greenhouse gas emissions over these fossil fuel products. So, what if DME production was increased multifold and substituted for diesel for use in applications of railway, motor vehicle, agricultural pump, electrical backup generators?

Indeed, Andre Boehman, mechanical engineer at the **University**



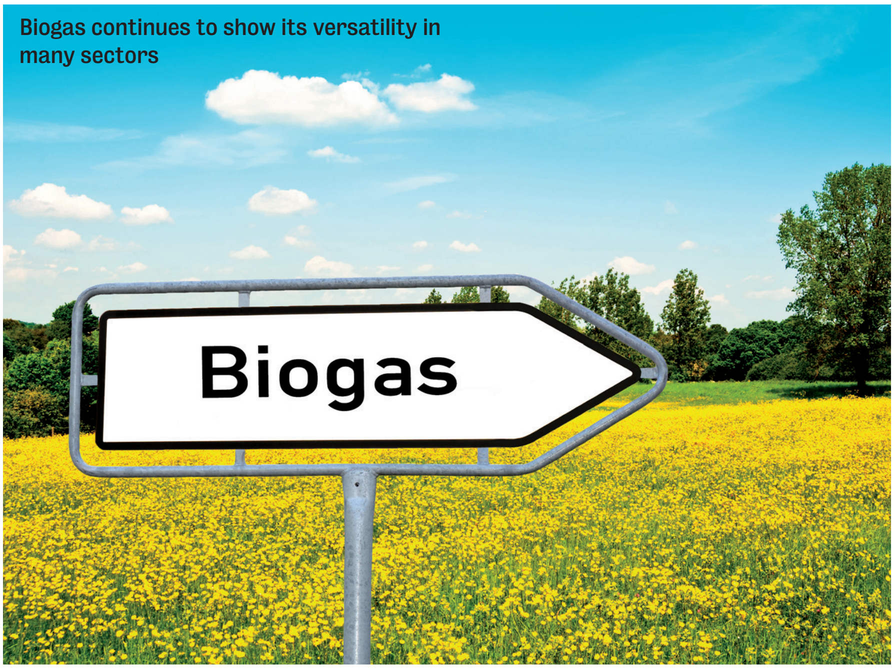
About: Nicholas Zeman is a Los Angeles-based, industrial news reporter who specialises in energy, finance and agriculture. His work was cited in U.S. Congressional testimony in debates over indirect land use change in 2009.

of Michigan, Lansing, says the recent OEM commitment signals the emergence of a major new market for biogas. DME is a diesel replacement product that can be made from “virtually any chemical feedstock,” he says. “While the volume of DME will be made from natural gas, real emissions reductions benefits come from using biogas.”

Chemrec notes DME made through the black liquor gasification route provides very high land-use efficiency - 11,000 kilometers per hectare of production, which is far above ethanol and biodiesel from wheat, corn or soy. Surprisingly, however, the fuel has not been used at any scale as a transportation fuel. Rather it has served as a chemicals feedstock and spray propellant, and China uses a large amount of DME (blended with liquid petroleum gas) for heating and cooking purposes.

But new market forces like stricter emissions regulations, the spread between natural gas and crude oil pricing, and innovations in processing technology make now an exciting time to commercialise DME, particularly in the heavy-duty trucking sector, according to **Oberon Fuels**, San Jose. Elliot Hicks, chief operating officer of Oberon, is excited about Volvo’s commitment to the fuel, and says his company will be the first to market DME in a meaningful way. This is happening because after years of market analysis Volvo saw that DME was the superior fuel “based on cetane level, zero particulate emissions and the potential to meet more stringent environmental guidelines,” according to Hicks.

Pulp and paper synergies



Biogas continues to show its versatility in many sectors

Chemrec says there is also an opportunity for pulp and paper mills to benefit from these market developments by producing biogas for further refining into chemicals and fuels streams: “It’s much more expensive to build a Greenfield chemical or fuel site,” Landval says. “With a pulp and paper mill all of the logistics and handling needs are accommodated. A methanol plant by contrast is a 4.5 year construction project and an investment of US$500 million, while Chemrec can install a gasifier and refining system for much less.”

In fact, Chemrec says, there are some 300 pulp and paper mills with old recovery boilers that soon need to be replaced. “Chemrec’s gasification unit is a more economical replacement which transforms the mill into a biorefinery. The mills can then offer the world low carbon fuels and chemicals of different kinds, and BioDME is only one of them,” the company says.

Black liquor upgrading is also much more than a niche market in several part of the world, especially in these areas where pulp and paper mills are ubiquitous:

“We can generate 24 percent of our energy needs from this feedstock in Sweden; in Finland the volume is even higher, near 50 percent, while Georgia in the United States...about 13,” Landval says, adding that the market for BioDME is expected to increase dramatically; and a growing global production capacity for DME and BioDME also means expanding and dynamic markets for methanol, which can also be made from methane-rich biogas.

Gasifying 40 to 50 percent of the synthesis gas from black liquor to DME in Sweden could yield huge amounts of clean burning transportation fuels, and making DME from black liquor has big gains over ethanol and biodiesel, Landval says: “It achieves a 97-plus percent reduction over petroleum in life cycle greenhouse gas emissions, while biodiesel

Diesel also remains the work horse of the transportation industry. Biogas has an opportunity here and through methanol and dimethyl ether (DME) is being offered an inroad into the market.

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is 66 percent and corn ethanol is 27 percent."

Superior fuel

DME can be burned in diesel engines, but needs different fuel injection and exhaust systems than its petroleum counterpart. But this is not a weakness. Boehman says a major advantage of DME is that it burns clean and needs no particulate filter, greatly increasing the efficiency of the compression ignited engines which use it as a fuel.

Hicks says DME emerged after years of market analysis as Volvo's foundation for a new vehicle line "based on cetane level, zero particulate emissions and the potential to meet more stringent environmental guidelines."

There has been, however, virtually no political support for DME - usually necessary to help the emergence of alternative fuels - because there was no extant, compatible technology to support the fuel's use, Boehman says. "For years I couldn't find a single research dollar. The U.S. government was focused on hydrogen and drop-in fuels, and there was not enough DME vehicles to really peak their interest. I hope that starts to change now that Volvo and Mack have committed."

Energy companies did not want to create a supply chain without enough vehicles on the market, and OEMs did not want to create product lines without a fuel supply. It was Oberon Fuels that helped Volvo see past this "chicken-and-egg" scenario—the question of creating a DME fuel supply or engine technology first. "Oberon's concept was to create fleet scale production units that can fuel 75 to 100 trucks," Boehman says. "The plan is to have fuel systems onsite for fleet managers as Volvo rolls out small fleets. It's an enormous historic event for DME and biogas."

Oberon's modular production units produce 3,000–10,000 gallons of DME per day. The units convert methane to DME efficiently and at a price that is competitive with diesel. In addition, the distributed concept certainly has benefits for isolated biogas streams. "The modular design can be deployed to remote stranded-gas locations that can be difficult and expensive to harvest, and to industrial operations where our units can monetise waste CO_2 streams," Oberon says.

In addition to the emissions reductions it achieves over its diesel competitors, converting biogas to DME solves some logistical problems associated with liquefied natural gas. The fuel can be handled just like propane and the infrastructure is already in place to transport and distribute it. "If you are a manager of turnpikes with a fleet that has to plough roads after a snowstorm, LNG has to be used within a limited time frame. It might work perfectly in certain logistic scenarios, but DME does not have those limitations. It has more range," Boehman says.

Regionally, rapidly

The current global production of DME is approximately 5 million tonnes per year, where the majority of the production is in China and based on coal gasification. Japan, Korea and Brazil also have significant production facilities. New production sites are planned or under construction in Egypt, India, Indonesia, Iran and Uzbekistan, and China's **National Development and Reform Commission** forecasts 20 million tonnes of DME production capacity by the year 2020.

In the U.S. and Europe, production is likely to be more decentralised. Oberon's small-scale production allows it to take advantage of smaller volume feedstocks that typically go unused - particularly biogas streams. The unit's modular design makes it easy to deploy to remote stranded-gas locations that are otherwise costly to access, and also to industrial operations where waste CO_2 streams can be captured to increase output.

Since production is not dependent on the price of crude oil and the Oberon process uses multiple feedstock sources, the price of DME is expected to be more stable than that of diesel - this is a major selling point for Volvo and other OEM's. Converting biogas to DME solves major logistical problems because DME requires no high-pressure CNG components or expensive cryogenic tanks.

"Ultimately we want to make the process easier for the OEMs. There are all these fuel sources and a multitude of products, but DME is a product that can be made from virtually any chemical or fuel feedstock," Hicks says. "It's one molecule and the simplicity helps the OEMs navigate the complex and complicated alternative fuels landscape."

Also, buying a modular production unit to fuel one fleet at a time involves a much smaller capital investment for DME users. The plants can be deployed with a capital cost that is in sync with the market. Depending on location, the units cost approximately US$15 million. They produce 10,000 gallons per day and can fuel about 100 trucks. "Process skids can be delivered in parallel to the installation site," Boehman says. "In these early stages of DME deployment we want to do it regionally and rapidly so that systems are in place by 2015 when those vehicles hit the road."

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